MATRIX CHARACTERISTICS AFFECTING TREATMENT COST OR PERFORMANCE (2)

Table 2 lists selected characteristics of untreated soil from Burning Ground No. 3.

Table 2. Matrix Characteristics

Soil Classification	Information not available
Clay Content and/or Particle Size Distribution	0.032 mm (mean particle size)* 31.5% clay, 30.9% silt, 35.3% sand, 2.3% gravel*
Moisture Content	17.5 %*
Oil & Grease or Total Petroleum Hydrocarbons	Information not available
Bulk Soil Density (3)	1.6 tons/cy

* Average value from the Proof of Performance Test (2).

TREATMENT SYSTEM DESCRIPTION

PRIMARY TREATMENT TECHNOLOGY (5)

Soil Ex-Situ – **Low Temperature Thermal Desorption**

SUPPLEMENTARY TREATMENT TECHNOLOGIES (5)

Pretreatment (Solids) – **Screening**
Post-Treatment (Solids) – **Quench**
Post-Treatment (Air) – **Baghouse**
Post-Treatment (Air) – **Catalytic Oxidation**
Post-Treatment (Air) – **Quench**
Post-Treatment (Air) – **Scrubber**

TIMELINE (1,2,3,10)

Date	Activity
August 30, 1990	LHAAP installation added to the NPL
December 30, 1991	CERCLA Section 120 Agreement (Federal Facility Agreement) between LHAAP, U.S. EPA and TNRCC became effective
December 1993	Treatability study performed
September 8, 1994	Proposed Plan for the Early Interim Remedial Action released by USACE and U.S. EPA
September 15, 1994	Public meeting held to present the Proposed Plan and solicit comments
February 28, 1995	TNRCC concurs with U.S. EPA's recommendation of using LTTD for soil treatment
May 12, 1995	Interim ROD signed by U.S. EPA Region VI Administrator.
November 1996	Notice to Proceed issued to Radian for Burning Ground No. 3 soil remediation delivery order

Date	Activity
January 13 – February 12, 1997	Mobilization and set-up of soil treatment units
February 1997	Soil treatment plant setup complete: start up and shake-down
February 13-15, 1997	Proof of Performance Test
February 18 - December 10, 1997	Soil/source material excavation and full-scale operation of treatment system
December 11, 1997	Soil remediation completed; treatment system shut down
January 19 – 23, 1998	Demobilize catalytic oxidation unit
January 26 – 30, 1998	Demobilize thermal units
December 8, 1997 – January 9, 1998	Dismantle and demobilize tent structures
January 26 – March 27, 1998	Remove soil staging pad
November 24, 1997 - June 9, 1998	Site restoration

TREATMENT SYSTEM SCHEMATIC AND TECHNOLOGY DESCRIPTION AND OPERATION

Figure 4 shows a process flow diagram for the mobile LTTD system used to treat ex-situ soil at Burning Ground No. 3.

Initial Activities (4)

Initial activities included:

- Construction of a soil handling and dewatering pad;
- Construction of a treated soil staging area;
- Mobilization and setup; and
- Conducting a Proof of Performance test.

Soil Treatment Plant Description and System Operation (4,5)

The soil treatment plant (STP) was designed as a stand alone, mobile processing unit for treating solid materials contaminated with chlorinated and non-chlorinated hydrocarbons. The STP utilized a non-contact, counter-current, low-temperature, thermal desorption process which volatilized target organic contaminants from the soil into the air within the system. The airborne contaminants were then catalytically oxidized in a specially designed low-temperature, catalytic oxidation system designed to destroy chlorinated organics.

Pretreatment

- Contaminated soil was excavated from previously designated areas and staged at the soil handling and dewatering pad.

- All contaminated feed material passed through a vibrating screen that removed debris greater than 3 inches in diameter from the STP feed stream. Removed debris was steam cleaned in batches and transported to the treated soils pad for backfilling with treated soils.

- Some feed materials were blended with treated soils using a front-end loader prior to placement on the screen in order to improve soil-handling properties.

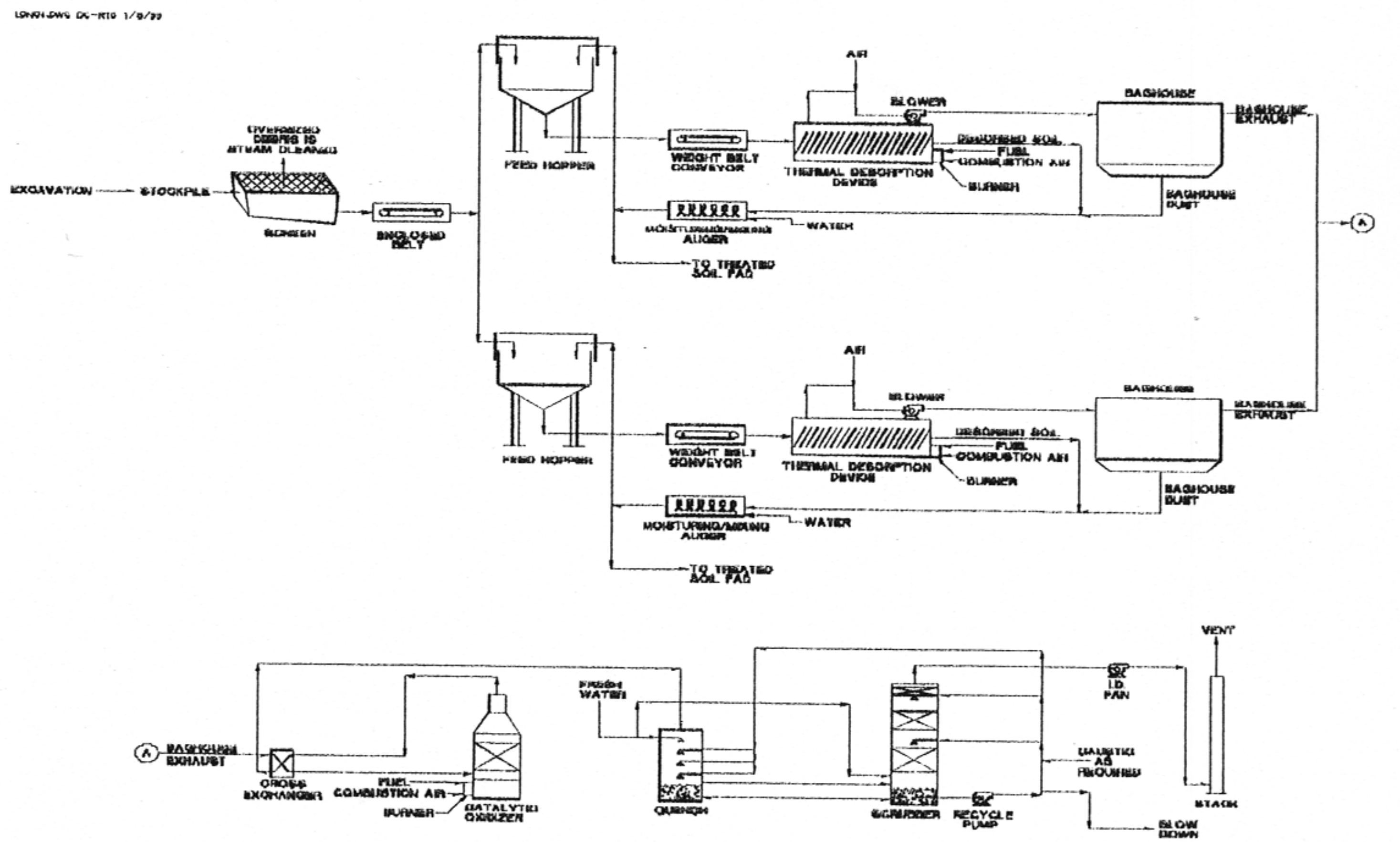

Figure 4. Process Flow Diagram

- Contaminated materials passing through the 3-inch screen were placed onto two enclosed belt conveyors. The conveyors transferred the material to the feed hopper on each thermal desorption unit.

Primary Thermal Desorption Trailers

Two identical thermal desorption systems were operated in parallel. Each desorption trailer was 47 feet long by 8.5 feet wide and had an integrated control panel. The thermal desorption process is described below.

- A vibrating 3 CY hopper directed feed materials onto a variable speed cold feed conveyor which dropped material onto the fixed speed continuous weigh conveyor. The weigh belt weighed the contaminated materials being processed and fed them into the rotary drum desorption chamber.
- As needed, hot baghouse dust was recycled into the feed hopper for blending with difficult-to-feed soils. This blending enhanced feed handling characteristics by reducing plasticity and/or moisture content.
- The soil was heated as it moved down the counter-current rotary drum, volatilizing moisture and lighter hydrocarbons from the soil particles. An induced draft (ID) fan pulled gases from the desorption chamber into the baghouse. The soil residence time in the rotary drum was typically 4 to 8 minutes with exit temperatures ranging from 350 to 650°F. The feed rate averaged 12 tons per hour per desorption trailer during normal operations.
- Process air passed through a pulse-jet baghouse designed to remove particulates greater than 5 microns in size. Process gases were maintained at high temperatures (up to 450°F) to avoid condensation of hydrocarbons in the baghouse. The baghouse exhaust was routed to the secondary treatment trailer.
- Treated soil discharged into a moisturizing/mixing auger unit. The auger was used to mix treated soil with baghouse fines and to wet processed soils for cooling, dust control, and remoisturizing which allows improved compaction during backfilling. A conveyor belt transferred the treated soil from the auger to the treated soil pad.

Secondary Treatment Trailer

The exhaust from the two desorption trailer baghouses was combined and routed to the secondary treatment trailer. This trailer was 48 feet 7 inches long by 8.5 feet wide. The secondary treatment process is described below.

- VOC-laden gas from the baghouses passed through the tube side of a cross exchanger where it was preheated with hot exit gases from the catalytic oxidizer. The gas then moved through the catalyst preheater section where it was heated to approximately 680°F and sent through the catalyst bed.
- In the catalyst bed, hydrocarbons were converted to carbon dioxide, water vapor and acid gases (HCl) through a catalytically driven oxidation reaction. The hot gases exiting the catalyst bed then passed through the shell side of the cross exchanger thereby preheating incoming gases to the oxidizer.

- The outlet from the catalytic oxidizer was directed into a multi-stage quench, followed by a packed bed, counter-current, acid absorption column. The quench section reduced the temperature of oxidizer exhaust to approximately 130°F and absorbed a fraction of the HCl contained in the exhaust. The remaining HCl vapors were removed (> 99.9% removed) in the scrubber. Sodium hydroxide was metered into the recirculating scrubber solution to maintain a neutral pH. The tower was packed with polypropylene packing and included a demister to remove entrained water droplets.

- The air stream was pulled through the scrubber and forced out the exhaust stack by a 60-horsepower ID fan. The stack was mounted over the fan, and was 18 feet tall with a 22-inch diameter. Stack gases were monitored continuously for total hydrocarbons (THC), O_2, CO and CO_2.

Wastewater Treatment (4)

- Any groundwater or surface water encountered during excavation and backfilling was collected in appropriate containers and taken to the groundwater treatment plant (GWTP).

- Contaminated liquid residue from debris cleaning drained into a sump at the soil handling and dewatering pad. The sump contents were pumped periodically to the GWTP.

- Scrubber blowdown water was neutralized and discharged directly if the discharge requirements were met. If the discharge requirements were not met, the blowdown water was sent to the GWTP.

Post-Operation (4,5,14,15,16)

When soil treatment operations were completed, the treatment system was shut down and dismantled for demobilization from the site. The treated soil was used as general fill material for landfill caps at LHAAP Sites 12 and 16.

Site restoration activities were initiated upon completion of treatment operations. The site was restored to its original condition to the extent possible, including the rebuilding of damaged and/or removed access roads and other structures.

No formal final inspection was conducted at the completion of the interim remedial action for soils at Burning Ground No. 3. The USACE Site Manager, Oscar Linebaugh, was on-site daily to observe and approve of the operations.

Personnel Requirements (4)

Operation of the STP normally required 3 to 4 personnel, including the following positions:

- A lead thermal desorption unit operator,
- A thermal desorption unit operator,
- A materials feed equipment operator, and
- An additional operator, as needed, during process upsets.

Health and Safety Requirements (5,11)

All Radian and subcontractor personnel who performed work within the exclusion zone complied with the training and medical surveillance requirements of OSHA 29 1910.120, the USACE Safety and Health Requirements Manual, EM-385-1-1, and the Radian/DEI Corporate Health and Safety Plan. All personnel assigned to the project attended site-specific safety training.

Health and safety monitoring of the work area was performed on a regular basis. The following monitoring equipment was used, depending on the operation:

- Organic vapor analyzer (OVA) equipped with a photoionization detector (PID),
- Combustible gas indicator/oxygen level meter,
- Respirable dust meter, and a
- Sound level meter.

Modified Level C was typically worn for any intrusive work with untreated soil, including sampling in the waste feed storage tent and desorber operation. Modified Level C included a hard hat, Tyvek, steel-toed boots, gloves and safety glasses. Full-face, air purifying respirators with combination organic vapor and HEPA cartridges were immediately on hand if conditions changed, as determined by the OVA.

During initial excavation activities within the burning ground, portions of pyrotechnics produced at LHAAP were unearthed. This provided the possibility that completely intact pyrotechnics that were still "live" could exist within the burning ground. All excavation and material handling equipment was fitted with Lexan sheeting to protect workers in the event a live pyrotechnic was detonated. As pyrotechnic items and/or fragments were found, work was stopped and an ordnance expert determined if the item was inactive or live. Inactive items were fed to the STP with other source materials, and live items were detonated off site.

OPERATION AND MAINTENANCE ACTIVITIES (15,16)

Soil treatment activities associated with the interim remedial action at Burning Ground No. 3 is complete. There are no long-term, post-operation O&M issues associated with the interim remedial action. No additional remedial activities have been specified for Burning Ground No. 3 at this time. Further remediation activities may be recommended following the completion of the remedial investigation/feasibility study for the site, which is scheduled for completion in late 1999. Deed restrictions and fencing to limit site access may be included as conditions of the ultimate disposition of the site.

Remediation of contaminated groundwater at Burning Ground No. 3 is on-going. O&M requirements for the interim groundwater remedial action include operation of the treatment system and semi-annual sampling and analysis. This system is currently expected to operate for approximately 20 years.

OPERATING PARAMETERS AFFECTING TREATMENT COST OR PERFORMANCE (3,4,14)

Table 3 lists operating limits for the STP. If system operations deviated from acceptable operating conditions and/or exceeded a limit, an alarm would be initiated or the system would shut down.

Table 3. Operating Limits

Parameter	Set Limit	Interlock
Weigh Belt	Loss of operation	Alarm Only
Drum Burner Flame	Loss of flame	Alarm/Controlled System Shutdown
Gas Pressure in Drum Burner	4" wc (min)	Alarm/Fuel Feed and Burner Shutdown
	17" wc (max)	Alarm/Fuel Feed and Burner Shutdown.
Combustion Air in Drum Burner	Loss of air flow	Alarm/Drum Burner Shutdown
Baghouse Inlet Temperature	≥470°F	Prealarm/Alarm/Drum Burner Shutdown
Compressor Air Pressure	≤80	Controlled System Shutdown
Gas Pressure in Catalyst Preheater Burner	4" wc (min)	Alarm/Controlled System Shutdown
	17" wc (max)	Alarm/Controlled System Shutdown
Combustion Air in Catalyst Preheater Burner	Loss of air flow	Alarm/Controlled System Shutdown
Catalyst Inlet Temperature	≤750°F	Alarm/Controlled System Shutdown
Catalyst Outlet Temperature	≥830°F	Alarm/Controlled System Shutdown
Quench Water Flow	≤60 gpm (total)	Emergency Quench Activation
Quench Exit Gas Temperature	≥180°F	Controlled System Shutdown
Scrubber Recirculation Water Flow	Loss of flow	Alarm/Controlled System Shutdown
Scrubber/Quench Sump Liquid Level	Low	Close Blowdown Valve
	Low/Low	Alarm/Emergency Quench Activation, Controlled System Shutdown
	High	Open Blowdown Valve
	High/High	Controlled System Shutdown
System Fan Air Flow	Gas pressure@drum>Gas pressure@I.D. fan	Controlled System Shutdown

wc - water column
gpm - gallons per minute

Table 4 lists values for parameters associated with operation of the LTTD unit at Burning Ground No. 3. The parameters were selected for this report based on USACE guidance.

Table 4. Operating Parameters

Parameter	Design	Limit	Actual*
Residence Time			
Soils in Rotary Drum	4 – 8 minutes	NA	6 – 7 minutes
System Throughput			
Waste Soil Feed Rate	10 – 15 tph	NA	12 tph/trailer
System Temperature:			
Soil Exit from Drum	350 – 650°F	NA	430°F
Catalyst Inlet	680°F	750°F (minimum)	760°F

NA – Not Applicable
tph – tons per hour

* Average values during full-scale operations.

TREATMENT SYSTEM PERFORMANCE

PERFORMANCE OBJECTIVES (2.4)

- The excavated soil and source material was treated according to the requirements of the LDRs under RCRA. Treatment levels are based on the Treatability Variance Procedure of 40 CFR 268.44 for the thermal desorption treatment of F002 hazardous waste.

- Table 5 lists the treatability variance levels provided in Highlight 5 of EPA Superfund LDR Guide #6A, "Obtaining a Soil and Debris Treatability Variance for Remedial Actions".

Table 5. Treated Soil and Source Material Objectives

Structural Functional Groups	Threshold Conc in Waste (ppm)	Treatment Requirements	
		Conc Range (ppm) If Waste Conc < Threshold	% Reduction If Waste Conc > Threshold
Halogenated Aliphatics			
Methylene Chloride	40	0.5 – 2	95 – 99.9
Trichloroethylene	40	0.5 – 2	95 – 99.9
Vinyl Chloride	40	0.5 – 2	95 – 99.9
1,2-Dichloroethene	40	0.5 – 2	95 – 99.9
1,2-Dichloroethane	40	0.5 – 2	95 – 99.9
1,1-Dichloroethene	40	0.5 – 2	95 – 99.9
1,1-Dichloroethane	40	0.5 – 2	95 – 99.9
Tetrachloroethane	40	0.5 – 2	95 – 99.9
Chloroform	40	0.5 – 2	95 – 99.9
1,1,1-Trichloroethane	40	0.5 – 2	95 – 99.9
Trichlorofluoromethane	40	0.5 – 2	95 – 99.9
Other Polar Organics			
Acetone	100	0.5 – 10	90 – 99.9
Slightly Polar Organics			
Toluene	100	0.5 – 10	90 – 99.9
Ethylbenzene	100	0.5 – 10	90 – 99.9
Xylene	100	0.5 – 10	90 – 99.9
Styrene	100	0.5 – 10	90 – 99.9
Benzene	100	0.5 – 10	90 – 99.9

- If the concentration of the constituent in the waste feed was less than the threshold concentration, the waste was treated to within the concentration range. If the waste was above the threshold, the waste was treated to reduce the concentration of the constituent in the waste to within the specific reduction range. Table 8 lists actual untreated soil concentrations from the Proof of Performance Test. Table 10 lists ranges of contaminant concentrations in untreated soil observed during remedial activities.

- The following table provides the air emissions requirements for the STP at Burning Ground No. 3.

Table 6. Air Emission Objectives

Parameter	Performance Criteria	Regulatory Basis
Total Chemicals	<5 ton/yr or <6 lb/hr	TNRCC Standard Exemptions 68 and 118 (b), (c), and (d)
Particulate Matter	25 ton/yr	TNRCC Standard Exemption 116
2,3,7,8 –TCDD TEQ	0.2 ng/dscm @ 7% O_2	Recommended standard (for incinerators)

TCDD TEQ – Tetrachlorinated dibenzo-p-dioxin Toxic Equivalents Quotient
ng/dscm – nanograms/dry standard cubic meter

- Both real time and time integrated air monitoring samples were taken on-site and at locations relevant to nearby residential communities to confirm that regulatory levels are not exceeded. The maximum allowable emission concentrations were 260 $\mu g/m^3$ for methylene chloride and 1,350 $\mu g/m^3$ for TCE. These limits are based on short-term effects screening levels for a receptor located 1,200 meters from the excavation site.

TREATMENT PLAN (2,4,6,10)

Following setup of the STP in January and February 1997, a Proof of Performance test was conducted. This test consisted of three runs conducted from February 13 to 15, 1997. Contaminated soils excavated from Sites 18 and 24 at Burning Ground No. 3 were used for the test. The testing was performed under high waste feed rate conditions to develop emissions estimates under worst case conditions. The three runs confirmed that the STP could meet the performance criteria for soil and source material treatment, as well as air emission requirements. The following table summarizes the results of the Proof of Performance test.

Table 7. Proof of Performance Results

Run	VOC Conc in Treated Soil (ppm)	Total Chemical Emissions		Particulate Emissions (ton/yr)	2,3,7,8-TCDD TEQ (ng/dscm)
		Ton/yr	Lb/hr		
Criterion	0.5 – 2 (most stringent range)	<5	<6	<25	<0.2
Run 1	<0.5	<5	<6	1.5	0.03
Run 2	<0.5	<5	<6	0.8	0.02
Run 3	<0.5	<5	<6	1.6	0.01

TREATMENT PERFORMANCE DATA (2)

Table 8 lists soil concentrations prior to treatment and following treatment performed during the Proof of Performance test. Grab samples were composited over one run, unless otherwise noted.

Table 8. Proof of Performance Test Soil Analyses[a]

Parameter	Waste Feed			Treated Soil		
	Run 1	Run 2	Run 3	Run 1	Run 2	Run 3
VOLATILE ORGANIC COMPOUNDS						
Halogenated Aliphatics, mg/kg						
Methylene Chloride	ND	0.007	ND	ND	ND	ND
Trichloroethylene	0.02	0.606	0.021	0.003	0.009	0.0006
Vinyl Chloride	ND	ND	ND	ND	ND	ND
cis-1,2-Dichloroethene	0.022	0.242	0.030	ND	0.005	ND
trans-1,2-Dichloroethene	ND	ND	ND	ND	ND	ND
1,2-Dichloroethane	ND	ND	ND	ND	ND	ND
1,1-Dichloroethene	ND	ND	ND	ND	ND	ND
1,1-Dichloroethane	ND	ND	ND	ND	ND	ND
1,1,1,2-Tetrachloroethane	ND	ND	ND	ND	ND	ND
1,1,2,2-Tetrachloroethane	ND	ND	ND	ND	ND	ND
Chloroform	ND	ND	ND	ND	ND	ND
1,1,1-Trichloroethane	ND	ND	ND	ND	ND	ND
Trichlorofluoromethane	ND	ND	ND	ND	ND	ND
Other Polar Organics, mg/kg						
Acetone	0.019	0.050	0.012	0.200	0.429	0.237
Slightly Polar Organics, mg/kg						
Toluene	ND	0.007	ND	0.003	0.002	ND
Ethylbenzene	ND	ND	ND	ND	ND	ND
m&p-Xylene	ND	0.009	ND	ND	0.003	ND
o-Xylene	ND	ND	ND	ND	ND	ND
Styrene	ND	ND	ND	ND	ND	ND
Benzene	ND	ND	ND	ND	0.002	ND
Methylene Chloride (grab), mg/kg	ND	0.164	ND	ND	ND	ND
Trichloroethene (grab), mg/kg	0.069	3.24	0.003	ND	0.007	0.0004

Table 8. Proof of Performance Test Soil Analyses[a] (Continued)

Parameter	Waste Feed			Treated Soil		
	Run 1	Run 2	Run 3	Run 1	Run 2	Run 3
PHYSICAL PROPERTIES						
Moisture, %	18.2	18.1	16.05	12.4	15.4	10.85
Plasticity Index	30	23	22	NA	NA	NA
Mean Particle Size, mm	0.042	0.021	0.033	NA	NA	NA
Gravel, %	4.1	2.9	0	NA	NA	NA
Sand, %	42.2	29.1	34.6	NA	NA	NA
Silt, %	21.8	34.7	36.2	NA	NA	NA
Clay, %	31.9	33.3	29.2	NA	NA	NA
METALS AND CHLORIDE[a]						
Arsenic, mg/kg	9.16	5.33	3.42	5.66	4.88	3.51
Barium, mg/kg	77.5	260	94.6	93.7	306	122
Cadmium, mg/kg	0.598	0.68	0.44	0.54	0.82	0.47
Chromium, mg/kg	20.5	23.9	16	21.2	32.5	16.6
Lead, mg/kg	8.59	31.7	9.18	10.6	25	10.7
Selenium, mg/kg	ND	ND	ND	ND	ND	ND
Silver, mg/kg	ND	ND	ND	ND	ND	ND
Chloride, mg/kg	10.9	33.8	8.32	NA	NA	NA

ND – Not Detected
NA – Not Analyzed
[a]Metals and chloride reported on a dry weight basis.

Table 9 presents the air emission results for the Proof of Performance test.

Table 9. Air Emissions for the Proof of Performance Test

Constituent/Parameter	Run 1	Run 2	Run 3
Methylene Chloride, ng/L	0.90	19.39	2.32
Trichloroethylene, ng/L	6.30	103.31	9.66
Vinyl Chloride, ng/l	ND	ND	ND
1,1-Dichloroethene, ng/L	ND	0.27	ND
1,1-Dichloroethane, ng/L	ND	0.19	ND
trans-1,2-Dichloroethene, ng/L	0.19	1.65	ND
1,2-Dichloroethane, ng/L	ND	0.81	ND
Tetrachloroethene, ng/L	ND	6.68	1.34
Chloroform, ng/L	36.71	35.76	38.91
1,1,1-Trichloroethane, ng/L	ND	ND	ND
Trichlorofluoromethane, ng/L	ND	0.19	ND
Acetone, ng/L	7.76	25.43	35.70
Toluene, ng/L	1.62	2.48	2.17
Ethylbenzene, ng/L	ND	0.16	0.29
m,p-Xylene, ng/L	ND	1.73	0.58
o-Xylene, ng/L	ND	ND	0.24
Styrene, ng/L	0.95	ND	0.39
Benzene, ng/L	5.41	7.31	5.84
PCDD/PCDFs TEQ, ng/dscm	0.0303	0.0222	0.0067
Total PCDD/PCDF Congeners, ng/dscm	1.02	0.79	0.25
Particulate, gr/dscf	0.006	0.003	0.006
HCl, ug/dscf	5.46	5.25	3.43
Chlorine, ug/dscf	0.95	0.38	0.96
Arsenic, ug/dscf	ND	0.006	ND
Barium, ug/dscf	0.184	0.116	0.177
Cadmium, ug/dscf	0.002	0.039	0.004
Chromium, ug/dscf	0.099	0.102	0.049
Lead, ug/dscf	0.097	0.070	0.022
Selenium, ug/dscf	0.069	0.090	0.067
Silver, ug/dscf	0.055	0.015	0.018
THC, ppm	24.9	37.1	13.5
CO, ppm	5.0	10.0	3.0
O_2, %	16.2	17.1	16.5
CO_2, %	2.9	2.7	2.6

ND – Not Detected
ng/L – nanograms per liter
ng/dscm – nanograms per dry standard cubic meter
gr/dscf – grains per dry standard cubic foot
ug/dscf – micrograms per dry standard cubic foot

Table 10 summarizes selected results from VOC analyses performed on samples collected from treated soil piles during full-scale treatment. Samples of the untreated and treated soil were collected for analysis approximately every 6 hours during LTTD operations. None of the treatment objectives were exceeded in any of the final treated soil samples. If an initial treated soil sample did not meet the removal criteria, the soil was retreated until the performance criteria were met.

Table 10. Summary of Results from Soil Analyses (Full-scale Operation)

Contaminant	Test Method 40 CFR 60 Appendix A	No. of Samples	Waste Feed Results (mg/kg)				Treated Soil Results (mg/kg)				Limit (mg/kg)
			Median (>DL)	Range	No. of Results >DL	No. of Results >Limit	Median (>DL)	Range	No. of Results >DL	No. of Results > Limit	
Methylene Chloride	8010	664	0.025	0.00008 - 153	91	3	0.015	0.00015 - <1.7	48	0	0.5 - 2
Trichloroethylene		664	0.058	0.00018 - 136	204	21	0.020	<0.010 - 0.231	43	0	0.5 - 2

Table 11 summarizes the THC emissions during full-scale operation of the STP. The emissions were below the TNRCC emission standards of 6 lb/hr and 5 ton/yr.

Table 11. Summary of THC Emissions at STP Stack (13)

Month	Days of Treatment	Hourly Maximum (lb/hr)	Daily Average (lb/day)	Monthly Totals (lb/month)
Feb-97	7	1.2	1.4	9.7
Mar-97	25	1.2	5.2	131.1
April-97	20	1.2	7.3	146.0
May-97	26	4.6	10.0	258.9
June-97	24	4.3	9.9	238.7
July-97	25	3.5	5.5	136.6
Aug-97	26	2.9	2.8	71.7
Sept-97	24	3.2	4.6	111.4
Oct-97	27	2.6	5.1	136.7
Nov-97	19	2.0	1.3	24.0
Dec-97	5	0.4	0.6	3.2
Total for operation = 1,268 lb (0.634 ton)				

PERFORMANCE DATA ASSESSMENT (2, 5,13)

- The waste feed sample analyses for VOCs during the Proof of Performance test shown in Table 8 indicate that all untreated soil concentrations were below the threshold concentration for use of percent removal treatment requirements. The applicable treatment criteria required reduction of soil concentrations to specific concentration ranges, depending on the chemical (see Table 5). The concentrations in the treated soils all met the treatment criteria during the Proof of Performance test.

- During full-scale operations, none of the treatment objectives were exceeded in any of the final treated soil samples. Most untreated soil samples (collected as grab samples) were already in the target concentration range of 0.5 – 2 mg/kg.

- Acetone concentrations were higher in the treated soil samples than in untreated soil samples collected during the Proof of Performance test. Possible explanations for the increase in acetone concentration include:

  - Simultaneous sampling of waste feed and treated soil were not exactly comparable due to soil residence time in the STP;
  - Partial decomposition of soil pollutants (aromatic hydrocarbons) in the desorber; or
  - Cross-contamination at the laboratory. (Note that laboratory method blank results did not indicate that the laboratory was a source of contamination.)

- Note that the STP was not designed to remove metals, so the concentrations in the waste feed and treated soil are not significantly different.

- Samples of scrubber blowdown water were collected during the Proof of Performance test. Arsenic, barium, cadmium, chromium, lead, selenium, chloride and sulfate were detected in the samples. The results showed negligible concentrations of VOCs in the scrubber water.

- Air emissions were in compliance with the applicable emissions standards throughout the Proof of Performance test and the period of full-scale operation. THC emissions totaled 1,268 lbs over the entire period of STP operation, February through December 1997, which is below the maximum allowable mass of 5 tons per year.

- The THC emissions values for February, March and April 1997 were biased low due to periods during which the emission spikes exceeded the instrument span. This bias affected about 3% of the data collected during the first three months. The span was adjusted beginning in May 1997 to accommodate the periodic concentration spikes.

- Ambient air monitoring results never exceeded regulatory levels.

PERFORMANCE DATA QUALITY (2,4,5,13)

Sampling and analysis activities were conducted in accordance with the procedures described in the Chemical Data Acquisition Plan. These activities include sampling and analytical procedures, along with specified calibration requirements, QC checks, and sample tracking. For this program, all data collected were considered valid, technically defensible, and reliable for decision making.

Soil Sampling

Grab samples of the waste feed and treated soil were collected approximately every 6 hours. Samples were collected using the scoop sampling procedure specified in U.S. EPA Method S-007 and S-005, "Sampling and Analysis Methods for Hazardous Waste Combustion". These samples were analyzed daily for VOCs (methylene chloride and trichloroethylene) via an on-site mobile laboratory in order to determine if the remediation goals were being met. Soil samples were analyzed at an off-site laboratory to confirm results from the on-site laboratory. For the first week of normal operations, one grab sample per day was sent for off-site analysis. The frequency of off-site analysis was gradually decreased to one sample every two weeks. Off-site laboratory analyses validated sample results from the on-site laboratory.

Continuous Emission Monitors

A member of Radian's Quality Assurance Staff conducted a performance evaluation of the continuous emission monitoring (CEM) system on February 28, 1997. Independent equipment and standards were used to conduct the performance evaluation. All performance evaluation results met the objectives stated in the Quality Assurance Project Plan for Air Measurements, dated December 18, 1996.

Single-point zero and span calibration checks were performed automatically by the CEM system each day at midnight. If the span or zero were outside of the specifications, the operator would do a manual calibration check and a manual recalibration, if necessary. Daily leak checks were performed on the system. No leaks were detected in the THC analyzer system during STP operations. Periodic multipoint calibration checks were completed; the results were recorded in the CEM logbook.

Zero and span checks during the Proof of Performance test were within ±3% for all parameters; zero and span drift checks were within ±4% for all parameters.

CEM data capture for the total 11-month treatment period was greater than 95%. There were periods of data loss due to power failures or instrument malfunctions and, during the first three months of treatment, low bias during periods when emission spikes exceeded the instrument span.

Stack Testing

Stack samples were collected using standard reference methods, following protocols including EPA Methods published in 40 CFR 60 – Standards of Performance for New Stationary Sources,

Appendix A – Test Methods and SW-846 Method 0030 (VOST) for VOCs.

For the Proof of Performance test, no problems with sample custody, tracking, or preservation were noted, with one exception. The one exception was the switching of filter media during Run #2 between the Method 5 and Method 26A sampling trains. The problem was noticed during the initial review of the post-test filter weights and was confirmed by visual and scanning electron microscope inspection. Sample integrity was maintained from collection through analysis, custody seals were intact, and chain-of-custody records were in order.

CERTIFICATION THAT REMEDY IS OPERATIONAL AND FUNCTIONAL (4,5,13,15,16)

The USACE, Tulsa District, delineated the locations of source material that would be excavated, hauled and treated at the STP at Burning Ground No. 3. These locations were identified as sites of past burning and burial activities based on historical investigations and visual observations. Each designated contaminated area was excavated, along with the surrounding three feet of soil. Excavation proceeded from areas with the highest contaminant concentrations to the areas of lowest concentrations, and was stopped after 30,000 CY were excavated per the contract specifications. No analytical criteria were established to signal the end of excavation in each area.

Prior to full-scale implementation operations, the STP went through a shakedown period and was subject to performance testing. Shakedown operations consisted of "dry" running (i.e., operating each unit without the presence of contaminated soils) of all LTTD and catalytic oxidation systems to confirm that each separate system unit and that the combined system functioned appropriately. In addition, the STP was "fine-tuned" under actual operating conditions to assure that the system could operate over a long period of time under expected operating conditions. After the shakedown period, a Proof of Performance test was conducted to verify that the STP could meet the specified criteria for soil and source material treatment and air emissions. The test successfully demonstrated that the STP could meet these criteria.

During full-scale operations, the treated soil was sampled approximately every six hours. Analytical results confirmed that the treated soil met all of the treatment objectives. Stack emissions were continuously monitored for THC and CO and periodically tested for a more comprehensive list of pollutants using manual methods. Air emissions were in compliance with the applicable emissions standards throughout the operating period.

USACE personnel were on-site daily to observe and approve of the operations.

TREATMENT SYSTEM COST

PROCUREMENT PROCESS (5,10,15)

Radian International (formerly Dow Environmental Inc.) was selected to design, construct, test and operate the LTTD system for this site. The soil remediation project was not competitively bid as a stand-alone project. It was negotiated as a service to be provided under the competitively bid contract for the groundwater remediation project. The groundwater contract was awarded to Radian and was structured as a cost-reimbursable project with a 3% fee added.

Radian subcontracted with the following companies to perform the listed project tasks:

Subcontractor	Tasks
OWC Inc.	Desorber mobilitization and set-up.

Integrity Inc.	Installed tents over the untreated and treated soil staging pads.
OJ Voyles	Transportation of treated soil from the treated soil tent to landfill sites 12 and 16 at LHAAP.

TREATMENT SYSTEM COST (3,10,15)

The total project cost for soil remediation of Burning Ground No. 3 was $4,886,978. The total volume of soil treated was 32,293 CY or 51,669 tons. Therefore, the cost for treatment was $151 per CY or $95 per ton of contaminated soil. Table 12 summarizes the costs for construction and operation of the thermal desorption system.

Table 12. Summary of Actual Soil Treatment Costs (15)

Activity	Cost
Mobilization and preparatory work	$142,362
Monitoring, sampling, testing	$233,298
Site work, utilities, access roads	$223,182
Excavation, backfill, site restoration	$810,709
LTTD Operation	$2,879,255
Emissions monitoring, sampling and analysis during excavation	$306,318
Demobilization	$47,393
Personnel Subsistence/Travel	$102,122
Contract Fees (3%)	$142,339
Total	$4,886,978

COST SENSITIVITIES (1,10,15)

The treatability studies investigated high temperature incineration and low temperature thermal desorption. These two technologies were estimated to have the same annual operation and maintenance cost ($50,000) but significantly different capital costs ($26M for incineration, $10M for thermal desorption).

Rental and operation of the LTTD system was the largest expense of the soil treatment costs.

Under the soil treatment contract, two daily billing rates were established for use of the equipment that comprised the STP: one rate for when the STP was operational, and a second, lower rate for when the STP was not running that accounted for depreciation of the equipment. The scope of the project was controlled by the predetermined volume of soil to be treated of 30,000 CY. A competitive bid approach would not have likely affected the costs but would have delayed the schedule during USACE review of multiple bid packages.

REGULATORY/INSTITUTIONAL ISSUES

Because this project was performed under CERCLA regulations, it was not necessary to obtain permits from local regulatory authorities for on-site activities. This Interim Remedial Action does not constitute the final remedy at the site. However, it did comply with Federal and State applicable or relevant and appropriate requirements. The following permitting, approval and public relations issues were encountered on this project:

- A public meeting was held on September 15, 1994 to present the Proposed Plan for the interim remedial action and to solicit comments. A Community Relations Responsiveness Summary provided written responses to public comments on the Proposed Plan.

    - On February 28, 1995, TNRCC wrote a letter of concurrence with EPA's recommendation of using LTTD for soil treatment at Burning Ground No. 3.

- The US EPA Region VI administrator signed the ROD on May 12, 1995.

OBSERVATIONS AND LESSONS LEARNED

COST OBSERVATIONS AND LESSONS LEARNED (3,5)

The initial scope of the soil remediation project was to treat 50,000 cubic yards: 30,000 cubic yards from the identified hot spots and trenches and 20,000 cubic yards from excavation of the interceptor collection trench (ICT) for the GWTP. It was assumed that the ICT excavation soil was contaminated and would need to be remediated. EPA provided a protocol for performing a statistical sampling and data evaluation for soil, to determine if it exceeded action levels. Radian followed these protocols and determined that a minimal amount of the ICT excavation soil (1,030 cubic yards) required treatment. Because soil treatment volumes were lower than expected, overall project costs were reduced from the original estimate.

The original work plan described the treatment system as consisting of one thermal desorption unit followed by two catalytic oxidizer units in parallel. The treatment system implemented consisted of two thermal desorption units in parallel followed by one catalytic oxidizer unit. Use of two desorbers decreased the project duration by treating soil at a higher daily rate.

Approximately 10 to 15% of the cost of monitoring, sampling and analysis are attributed to ambient air monitoring. Considering the remoteness of the site to potential neighbors, ambient air monitoring may not have been necessary. The regulators were pleased that the Army considered and monitored perimeter emissions during this project.

PERFORMANCE OBSERVATIONS AND LESSONS LEARNED (5,14)

The intent of the Proof of Performance test was to evaluate the treatment train under worst-case conditions. In general, the feed soil used during the test was already within the compliance criteria. The regulatory agencies decided to proceed and focused on maximizing the feed rate of the soil. Future projects should attempt to conduct performance testing on soils that are representative of site conditions. To be conservative, contaminant concentrations on the higher end of what is expected on-site should be used.

Soils that were very wet were combined with treated soil in order to reduce the moisture content prior to being fed into the LTTD unit.

The clay in the soil would sometimes plug the area between the hoppers and feed belts. The plugging did not cause major downtime. Use of shredders may have reduced the plugging but would not have been economically feasible.

OTHER OBSERVATIONS AND LESSONS LEARNED (14)

Communications between all interested parties went smoothly due to regular meetings and close proximity of personnel. Daily tailgate meetings were conducted by the remediation contractor and subcontractors. Weekly project meetings were held that included the USACE, the base, and major contractors. Each interested party had representatives on-site during operation of the LTTD system, so additional meetings were able to be organized quickly.

There were no conflicts between remediation activities and current site operations. Arrangements were made for the ACD to be temporarily shutdown during excavation and restoration around the unit, facilitating remediation activities in this area of the burning ground. The temporary shut down allowed for faster progress of remediation in this area and decreased the health and safety risk that might have existed if remediation contractors and base personnel had been competing for access to the same area.

The contractor believed that wearing (or having available) Level C personal protective equipment (PPE) during hot weather conditions was necessary to ensure the health and safety of his employees and to maintain the level of protection necessary to perform the work. The crew did not have trouble with heat stress due to stringent work and break schedules and good verbal communication. No heat stress-related project delays or cost increases were noted during the project. Based on these facts, the contractor believed that use of Level C PPE was worth the potential risks associated with heat stress and other hot weather-related complications.

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